

## A PENICILLIN-TREATED SERIES OF CASES OF OSTEOMYELITIS IN CHILDHOOD

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It is now well recognized that the use of penicillin in staphylococcal infections of the bones and joints of children has produced a most striking improvement in results. There is still, however, no agreement as to the dosage desirable or as to the surgical intervention which may be necessary in addition. In consequence the following account of work at the Hospital for Sick Children, Great Ormond Street, may be of interest, especially as in certain ways the treatment given has differed from that generally advised. The series described in the first two groups is a consecutive one without selection of any kind. In the third group, selection of cases is essential to the treatment advocated. An analysis of the cases is given in Tables I-III.

### Group I: Acute Osteomyelitis (31 cases)

#### Pathology

*Age distribution*:—Sixteen were infants less than 1 year old; the others ranged up to 12 years. *Site of infection*:—The lesions were in the long bones in 23 cases, other sites being the external cuneiform, the frontal bone, the sternum, and the maxilla—a curiously common site in infants. *Complications prior to penicillin treatment*:—In four cases the infection spread from the bone to a neighbouring joint, causing a purulent arthritis. Soft-tissue abscesses occurred in 12 and septicaemia in three cases. Pneumonia preceded bone disease in three cases; otitis media and mastoiditis occurred in two cases, and femoral thrombosis in one case. *Duration of disease before admission*:—Nineteen cases were of less than one week's standing, 8 up to four weeks, and 3 up to eight weeks.

*Bacteriology*.—Coagulase-positive *Staphylococcus aureus* was grown from the blood stream in two cases, and from abscesses or joints in 12 cases. Haemolytic streptococcus was isolated from blood culture in one case and from abscesses or joints in three cases. Coagulase-negative *Staph. albus* was grown from an abscess in one case. All the micro-organisms isolated from these cases were highly penicillin-sensitive. In Case 5, however, a strain of haemolytic streptococcus, Lancefield group A, was ten times less sensitive than the standard Oxford strain of *Staph. aureus*. The child has made a complete recovery on the standard dosage of penicillin.

*Radiology*.—Changes in the x-ray picture are not to be expected before the tenth to fourteenth day. Their extent varies greatly, mainly according to the time at which penicillin treatment is begun. As changes may be very slight, radiographs of the sound limb are essential for comparison. The earliest detectable change is loss of definition of the trabeculi or rarefaction of the affected bone. This may be accompanied or followed by the laying down of thin streaks of new bone outside the normal line of the periosteum. The changes may proceed no further and the bone return

to normal. On the other hand, very severe degrees of bony disorganization were seen, including in six cases the formation of apparent sequestra (see cases 8, 9, 12, 14, 17, 26). The severity of the radiological changes was out of all proportion to the clinical appearances and bacteriological findings. One point which has particularly impressed us is how these appearances will clear up completely without drastic surgery. It seems to us that these early radiological changes show disorganization of calcium deposition in a living bone rather than the actual death of that bone. There is need for further study of this most interesting point. In only one case (14) was a sequestrum removed. This was a particularly well defined and large one which occurred in the tibia after an infected intramedullary infusion. It was therefore not a typical case of osteomyelitis.

It should be noted, as regards both radiological and bacteriological evidence, that the abortive action of penicillin is so great that a diagnosis made on purely clinical grounds may never be confirmed in any other way.

#### Treatment

*Penicillin Therapy*.—Treatment was begun immediately after collection of bacteriological specimens without waiting for reports. The dosage was 1,000 units per lb. (454 g.) body weight per twenty-four hours, given by intramuscular injection every four hours. In two cases this amount was doubled with no difference in the result. We consider that the safest course is to continue this treatment for at least three weeks, although in many of our cases it lasted for no more than a fortnight. Occasionally sterilization of the bone lesion may take nearly three weeks.

*Surgical Treatment*.—An affected limb was immobilized in plaster in such a way that inspection of the affected region and aspiration could be easily performed. Immobilization was not prolonged much beyond the period of penicillin treatment, and movement was encouraged as soon as it was painless even in cases with marked radiological changes. In arthritis of the shoulder-joint the arm was merely bandaged to the side. Where our treatment differed from that generally followed was in 13 cases in which pus formed outside the infected bone. In all of these the pus was aspirated at intervals governed by the rate of re-forming pus. In most cases the aspiration was daily for the first few days, and after that at longer intervals when fluctuation could be detected. When pus was aspirated it was always replaced by injecting penicillin in a dose of 2,000 to 5,000 units. It is possible that this injection is unnecessary; but we feel that it can do no harm, and it appears reasonable to suppose that it may sterilize the cavity more rapidly than systemic penicillin alone.

In all cases—we must admit at first to our considerable surprise—pus finally ceased to form and healing was complete without sinus formation. The advantages of this conservative treatment are very great. It avoids that disastrous change in the outlook of the case which occurs when a single infection, controllable because penicillin-sensitive, becomes complicated by non-sensitive organisms. These secondary infections may come from anywhere, but two sources are impossible to eliminate when there is an open wound. The first is the skin, in which resistant organisms tend to develop under penicillin treatment. The second is the bowel, containing coliform bacilli, faecal streptococci, and other insusceptible bacteria. Contamination from minute quantities of faecal material is unavoidable in certain situations, particularly in infants.

#### Results

*Immediate clinical results* were most striking. Many of these children were admitted in great pain, with high

TABLE I.—*Acute Osteomyelitis*

Case No.	Age	Bone Lesions	Symptoms and Signs	Complications	Time Ill	Follow-up Time	Bacteriology		Surgical Treatment	Penicillin			Functional Result	Radiology
							Blood Cult.			Systemic	Local			
											Time	Total Dose (units)		
1	5 mths.	R. femur neck	Pain on movement of R. hip. T. 102° F. (38.9° C.).	Diarrhoea and vomiting	11 days	1 yr.	Neg.	None	Lorenz plaster. Hip: No pus aspirated. Aspirations 6 times	30 days	540,000	6 days	None	Large cavity upper end R. femur. Now normal. Periosteal elevation. Now normal
2	4 wks.	R. fibula	T. 102° F. Fluctuant hot swelling R. leg for 3 days. Diarrhoea 2 weeks	Soft-tissue abscess	3 days	2 yrs.	"	Staph. aur. coag.-pos.	Aspirations 6 times	6 days	54,000	6 days	10,500	"
3	2½ yrs.	"	T. 100-4° F. (38° C.). Tender swelling R. leg	None	3 days	1 yr.	"	None	None	14 days	420,000	14 days	None	Periosteal elevation. Now normal
4	6 yrs.	"	T. 101° F. (38.3° C.). Malaise. Tender swelling below R. knee. R. ankle inflamed	Soft-tissue abscess	6 days	19 mths.	"	Staph. aur. coag.-pos.	Immobilization. Aspirations 7 times	9 days	360,000	30 days	43,500	Considerable bone destruction and periostitis of shaft. Now solid new bone
5	7 wks.	Head of L. humerus	Pseudoparalysis L. arm 4 weeks. T. 99° F. (37.2° C.)	Arthritis L. shoulder	4 wks.	13 mths.	"	Haem. strep. Group A	Aspirations of joint 8 times	14 days	168,000	10 days	24,000	Erosion head of humerus. Now delay of epiphys. development
6	6 yrs.	L. tibia lower end	T. 104° F. (40° C.). Very ill. Tender L. ankle. Limp	None	2 days	18 mths.	"	None	Immobilization	10 days	400,000	10 days	None	Periosteal elevation. Bone destruction. Now normal
7	10 wks.	L. tibia and fibula, lower end	T. 100° F. (37.8° C.). L. leg hot, tender, swollen	Abscess R. side of chest	1 wk.	22 mths.	"	"	"	13 days	156,000	13 days	"	Periostitis and bone destruction. Now normal
8	9 yrs.	L. tibia lower end	T. 102° F. (38.9° C.). Swelling. Diarrhoea. Pain L. heel	Soft-tissue abscess	6 days	14 mths.	"	Staph. aur. coag.-pos.	Immobilization. Aspirations 11 times	24 days	2,116,000	21 days	82,000	Periosteal elevation. Much bone destr. of shaft. Sequestrum. Now sequestrum not evident. Regeneration
9	7 yrs.	L. tibia upper end	Pain L. leg. Feverish	"	2 wks.	18 mths.	None	"	Immobilization. Aspiration	14 days	420,000	14 days	None	Cavity L. tibia upper end. Sequestrum. Now regeneration. Much improvement
10	2½ yrs.	L. femur neck	T. 105° F. (40.6° C.). Swelling. Rigors. Semiconscious. Pain L. leg	Femoral thrombosis	4 days	2½ yrs.	"	None	Immobilization	8 days	320,000	8 days	"	Slight periosteal elevation. Now normal
11	10 mths.	L. ankle	Cold 2 weeks. Hot, swollen, very tender L. ankle. T. 102° F.	R. otitis media, septicaemia	1 day	13 mths.	Staph. aur. coag.-pos.	"	"	21 days	630,000	21 days	"	No disease of bone seen
12	3 mths.	L. tibia	Cellulitis after marrow drip for D. & V. and pyelitis. General condition poor. T. 102° F.	Cellulitis, pneumonia, septicaemia	1 mth.	2½ yrs.	"	Staph. aur. coag.-pos.	Immobilization. Abscess incised	8 days	112,000	8 days	"	Central bone cavity. Periostitis. Small sequestrum. Now normal. No difference in L. and R. No definite bone change at this age
13	7 mths.	Maxilla	Swollen face & L. eye, 4 days. Discharge from mouth. T. 104° F. (40° C.). Diarrhoea	Local abscess	4 days	19 mths.	Neg.	"	Aspirations twice	15 days	264,000	2 days	4,000	"
14	9 mths.	Both tibiae	Tibial marrow drips for pyelitis and D. & V. Very ill. T. 102° F.	Soft-tissue abscess. Fracture	10 days	22 mths.	"	"	Immobilization. Sequestrectomy	32 days	600,000	32 days	None	Periostitis. Bone necrosis. Fracture. Sequestrum L. tibia. Now sclerosis
15	11 mths.	L. femur neck	T. 104° F. Swinging. Tender L. thigh. Fretful	Supp. arthritis L. hip. Septicaemia	5 days	17 mths.	Haem. strep. Group A	Haem. strep. Group A	Immobilization. Aspirations 3 times	14 days	420,000	6 days	15,000	L. epiphysis not visible. Bone necrosis neck of femur. Now L. hip joint ankylosed
16	2½ yrs.	R. ext. tibia lower end	Dorsum R. foot swollen, tender leg. Hot, tender swelling L. leg & ankle. T. 102.6° F. (39.2° C.)	None	?	15 mths.	None	None	Immobilization	11 days	260,000	11 days	None	Bone destruction R. ext. tibia. Now normal
17	2½ yrs.	L. tibia lower end	Pain R. leg. Hot, tender swelling L. leg & ankle. T. 101.2° F. (38.4° C.)	Soft-tissue abscess	5 days	1 yr.	Neg.	Staph. aur. coag.-pos.	Immobilization. Aspirations 9 times. Bone drilled	35 days	2,100,000	30 days	1,045,000	Considerable bone destr. with sequestration & periostitis. Now sclerosis. Sequestrum no longer seen
18	7 mths.	R. ulna	Fusiform swelling R. ulna. R. ankle swollen, tender. T. 101.2° F. (38.4° C.)	None	3 days	14 mths.	"	None	Immobilization	10 days	300,000	10 days	None	Widening upper end of R. ulna. Now no abnormality
19	7 mths.	R. ankle	R. ankle swollen, tender. T. 101.2° F. (38.4° C.)	"	1 day	1 yr.	None	"	"	11 days	200,000	11 days	"	No definite bone disease
20	11 yrs.	L. fibula	Aching pain L. fibula. Bronchitis	"	6 wks.	13 mths.	"	"	None	8 days	480,000	8 days	"	Periosteal thickening L. fibula
21	10 yrs.	L. tibia lower end	T. 104° F. Rigors. Diarrhoea. Very bad pain & tender swelling L. ankle	"	3 days	7 mths.	Neg.	Neg.	Immobilization. Aspiration	21 days	1,280,000	21 days	10,000	Periosteal elevation and loss of bone structure. Small cavity in shaft. Now slight sclerosis

TABLE I.—*Acute Osteomyelitis (continued)*

Case No.	Age	Bone Lesions	Symptoms and Signs	Complications	Time Ill	Follow-up Time	Bacteriology		Surgical Treatment	Penicillin				Functional Result	Radiology
							Blood Cult.	Local		Systemic	Local	Time	Total Dose (units)		
22	9 mths.	Maxilla	T. 104° F. Fluctuant swelling hard palate. Discharge L. eye	Abscess of palate	2 days	0	None	Staph. aur. coag.-pos.	Abscess incised	14 days	250,000	None	None	Perfect	No definite bone lesion at this age
23	6 yrs.	Frontal bone	Tender swelling of face and forehead. Headache	Otitis media	2 wks.	5 mths.	"	None	None	16 days	576,000	"	"	"	Bone destrn. of frontal bone. Now improved
24	5 wks.	L. tibia lower end.	Swelling L. foot at 1 week. Swelling over sternum 1 day	Abscess over sternum	4 wks.	7 mths.	"	Staph. aur. coag.-pos.	Aspirations twice	21 days	250,000	2 days	2,000	"	Bone destruction sternum and L. tibia. Now improved
25	3 mths.	Sternum	Discharge L. eye and nostril. Swelling L. palate. Listless	Cellulitis of face	2 days	9 mths.	"	"	Abscess incised	15 days	450,000	None	None	"	No definite bone lesion at this age
26	4 yrs.	L. humerus upp. end	Pain, swelling L. shoulder region. T. 102° F. Rigors. Very ill	None	1 wk.	9 mths.	Neg.	None	Immobilization	9 days	540,000	"	"	"	Cavity upper end L. humerus. Suspected sequestration. Now normal
27	1½ yrs.	L. tibia	Very tender swelling L. lower leg	"	2 mths.	7 mths.	None	"	"	21 days	1,500,000	"	"	Walks well. Plays no games	Periosteal new bone & small cavity. Now sclerosis.
28	2 yrs.	R. tibia	Swelling R. leg after measles. T. 100° F.	"	6 wks.	8 mths.	"	Neg.	Immobilization. Aspiration	21 days	630,000	"	"	Perfect	Small round transclucency Cavities and new bone formation. Now no evidence of bone destruction or sequestration
29	4 mths.	Maxilla	Discharge from eye, nostril, and palate	Bolls on hard palate	4 days	10 mths.	Neg.	Staph. aur. coag.-pos.	None	13 days	195,000	"	"	"	No definite bone lesion at this age
30	4½ yrs.	L. tibia epiphysis	Painful swelling L. knee. T. 100° F.	Supp. arthritis L. knee after otitis media and pneumonia	4 days	1 yr.	None	Haem. strep.	Immobilization. Aspiration	10 days	600,000	1 day	4,000	"	Osteitis of epiphysis L. tibia. Now normal
31	5 wks.	L. humerus upp. end (head)	Tooth extracted at 1 week. Then septic gum. 1 week later, L. hip and shoulder swollen. Septic umbilicus. Diarrhoea. Snuffles	Supp. arthritis L. hip and L. shoulder. Subluxation(?) congenital) of L. hip	3 wks.	10 mths.	Neg.	Staph. albus coag.-neg.	Abduction & extension of legs. L. arm splinted. Aspirations 5 times	21 days	250,000	6 days	12,000	Shoulder perfect. Good hip movement	Defect upp. end L. humerus. Subluxation of L. hip. Now displacement of L. hip-joint as before. No evidence of ossification of head of L. humerus or L. femur. Bone healthy

TABLE II.—*Acute Suppurative Arthritis*

Case No.	Age	Bone Lesions	Symptoms and Signs	Complications	Time Ill	Follow-up Time	Bacteriology		Surgical Treatment	Penicillin				Functional Result	Radiology
							Blood Cult.	Local		Systemic	Local	Time	Total Dose (units)		
32	18 days	?	Loss of movement R. arm for 1 week. R. shoulder red, swollen. T. 99-6° F. (37.5° C.)	Supp. arthritis R. shoulder. Pneumonia. Septicaemia	1 wk.	21 mths.	Staph. aur. coag.-pos.	Staph. aur. coag.-pos.	Aspirations 15 times	10 days	84,000	18 days	28,000	Perfect	Widening of joint space. No bone disease. Now normal epiphysis
33	5 wks.	?	Swelling R. shoulder, after misplaced "kapton" inl. T. 103° F. (39.4° C.)	Supp. arthritis R. shoulder	1 day	23 mths.	Neg.	"	Immobilization. Aspirations 4 times	5 days	45,000	7 days	12,000	"	No bone lesion
34	10 yrs.	?	T. 104-2° F. (40.1° C.). Abdominal pain and vomiting. Swelling R. elbow	Supp. arthritis R. elbow after mastoiditis	5 days	11 mths.	None	Haem. strep.	Immobilization. Aspirations twice	16 days	960,000	2 days	40,000	"	"
35	2 yrs.	?	Meningococcal meningitis. Joints swelled up during penicillin treatment	Supp. arthritis R. knee and both elbows	1 wk.	6 mths.	"	Neg.	Immobilization. Aspirations 3 times	16 days	480,000	4 days	15,000	"	"

TABLE III—Chronic Osteomyelitis

Case No.	Age	Bone Lesions	Symptoms and Signs	Complications	Time Ill	Follow-up Time	Bacteriology		Surgical Treatment	Penicillin				Functional Result	Radiology
							Blood Cult.	Local		Systemic		Local			
										Total Dose (units)	Time	Total Dose (units)	Time		
36	11 wks.	L. 7th and 8th ribs	Discharging sinus in chest for 4 weeks. No constitutional upset	Discharging sinus	4 wks.	14 mths.	Neg.	Staph. aur. coag.-pos.	Resection 8th rib. Primary suture	14 days	200,000	10,000 at op.	Perfect	Bone destruction L. 7th and 8th ribs. Now 8th rib regenerated. No evidence of bone destruction	
37	4 mths.	R. 10th rib	Big abscess on back. T. 104° F. Six days' penicillin only. No bone lesion then. Sinus formation followed	None	5 wks.	20 mths.	"	"	Large sequestrum removed. Primary suture	13 days	210,000	3,000 at op.	"	Bone destruction R. 10th rib. Now some regeneration	
38	10 yrs.	R. os calcis	Limp for 6 mths. Swelling R. heel and pain	None	6 mths.	14 mths.	"	"	Sequestrum removed. Primary suture & catheter tied in	10 days	640,000		10 days	"	Bone destruction R. os calcis and sequestration. Now considerable regeneration
39	1½ yrs.	L. 6th rib	At 4 mths. abscess L. breast opened. Discharged for 2 mths. Now painful fluctuant swelling below L. nipple for 2 wks.	Abscess	14 mths.	9 mths.	"	"	Excision of L. 6th rib	11 days	330,000	10,000 at op.		Perfect. Wound healed by first intention	Bone destruction L. 6th rib. Now considerable regeneration
40	5 yrs.	L. ilium and L. tibia	Acute osteomyelitis L. tibia 2 yrs. ago, treated with penicillin and active surgery. 1 month later, pneumothorax & abscess L. hip, treated surgically; no penicillin. Progressed to chronic osteomyelitis	Pneumothorax, abscesses and sinuses	2 yrs.	2½ yrs.	None	"	(1) Tibia explored in acute stage (2) Abscess L. hip incised (3) Brodie's abscess scooped (4) Sinuses expld. Partial excision of L. ilium	10 days	1,600,000 None " 675,000	None " 10,000 at op. 200,000 at op.		Wound healed by first intention. Walking reasonably well with raised heel	Central cavity L. tibia. Bone destruction L. ilium. Hip subluxating. Now: Tibia: atrophy of diaph. No active disease. Ilium: Defect of crest healed. Left hip joint disorganized

temperatures, and some in a comatose state which before penicillin was a sign of grave danger to life. Within forty-eight hours, as a rule, the children were happy again, playing, sleeping, and eating well. Soft-tissue swellings, without the formation of pus, usually subsided in four or five days.

**Bacteriological Results.**—The blood when infected was sterilized in four to seven days. The cavities of abscesses and infected joints were sterile in less than three weeks in all cases.

**Functional results** were perfect in all cases but one. Full movement and power in the affected limbs were obtained in from five weeks to five months, according to the severity of the condition. There have been no recurrences and metastases of the kind so common formerly. The one unsatisfactory case points a moral, as the treatment advised was not properly applied. Case 15 received at first only a seven-day course of penicillin, and the hip, though suspected, was not aspirated. After transient improvement the blood culture became positive again and the child gravely ill. Aspiration of the joint with a full course of penicillin cured the infection, but the hip was damaged beyond recovery and is now ankylosed.

**Radiological results** were the re-establishment of normal bone pattern. The final absence of gross bone deformity was very striking.

#### Group II: Acute Suppurative Arthritis (4 cases)

**Pathology.**—Coagulase-positive *Staph. aureus* was isolated from the infected joints in two cases, and in one of these from the blood stream as well. No micro-organism was isolated from the joint of another case, but the arthritis developed as a complication of meningococcal meningitis under treatment. Haemolytic streptococcus was grown from the joint in one case in which arthritis developed as a complication of recurrent mastoiditis.

**Treatment.**—All these four cases were treated by conventional methods of aspiration and replacement by penicillin. A point of interest was the use in two cases of two needles, saline solution being injected through one to thin out unduly thick pus, which escaped by the other. There was no attempt at prolonged fixation or extension, the child being allowed to use the limb when it wanted to.

**Results.**—All recovered completely.

#### Group III: Chronic Osteomyelitis (5 cases)

**Pathology.**—This group of five cases consisted of three of osteomyelitis of the rib, one of the os calcis, and one of the upper part of the ilium—all of the too familiar kind in which a discharging sinus leads down to bare bone, more or less necrosed. The selection mentioned earlier consisted in picking cases in which the infected bone tissue could be removed without damage to the functions of the body. This limits the method of treatment described to such bones as the ribs, the fibulae, the sternum, the os calcis, and the crest of the ilium. In widespread infections of bones difficult of access it is unsuitable.

**Treatment.**—The infected bone was exposed and completely removed, taking with it a margin of healthy bone. All granulations were carefully scraped away and penicillin in solution or powder instilled. The wound was then sewn up completely, with the idea of avoiding contamination by penicillin-resistant organisms. Firm pressure was applied to it by means of an "elastoplast" dressing, and it was left untouched for a fortnight. There was no attempt to obliterate the cavity of the wound if this was difficult to do, the idea being to get healing by organization of a blood-clot sterilized by penicillin. Healing of this kind was obtained

first by Lister, who describes mixing blood and carbolic acid into a paste and using it to fill wounds.

**Results.**—When the dressing was removed healing in all cases was either complete or sufficiently advanced to shield the deeper parts of the wound from infection. All wounds were dry in three weeks from operation, and have remained so since for periods varying from nine months to two and a half years. It may be noted that no particular benefit has been observed to follow the local or general use of penicillin in cases in which all the infected bony and soft tissue could not be removed. Such sites of infection as the upper end of the femur or the vertebrae still remain most intractable once a communication, temporary or permanent, has been formed with the outer surface of the body.

### Summary and Conclusions

Three series of cases are reported: 31 of acute osteomyelitis; 4 of acute suppurative arthritis; 5 of chronic osteomyelitis.

Of the acute cases 50% were in infants under 1 year old.

Dosages of penicillin were relatively small—1,000 units per lb. (454 g.) body weight per twenty-four hours for three weeks.

In acute osteomyelitis and arthritis, surgery was confined to aspiration of pus. Immobilization was partial and for short periods.

Radiological changes observed were far less serious clinically than might have been expected from their marked character.

In suitable cases of chronic osteomyelitis excision of infected tissue and primary suture is advised.

Mortality was nil. Complete restoration of function occurred in all but one of the acute cases. There was apparent complete healing in all the chronic cases.

We wish to acknowledge the kindness of physicians and surgeons at the Hospital for Sick Children, Great Ormond Street, who have permitted us to include some of their cases in this paper. We are also much indebted to Miss Eileen Rawlings for her tireless clerical assistance.

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Extensions to Joyce Green Hospital (L.C.C.), Dartford, including new wards to accommodate 120 beds, a new main operating theatre, and a nurses' home, were completed in 1939, but the formal opening by Mr. A. Reginald Stamp, chairman of the Hospitals and Medical Services Committee of the London County Council, was delayed until April of this year. This was originally one of the three river hospitals under the control of the Metropolitan Asylums Board. The main hospital buildings were opened in 1903, following smallpox epidemics in the two previous years, to take the place of the Thames ships which were formerly employed as floating hospitals. Afterwards it was used for infectious diseases generally, and during the last eight years it has admitted general medical and surgical patients. As a war emergency hospital its previous accommodation of 986 beds was almost doubled. The wards newly constructed, however, were not brought into use during the war because the large amount of glass made them unsafe, and indeed the hospital suffered extensively and repeatedly from blast. The total cost of the new extensions is £134,000. One of the new wards houses neurosurgery and physiotherapy units and the other is for children. Ear, nose, and throat, ophthalmic, and dental clinics have been established in the new premises. At the opening ceremony Mr. Stamp said that the extensions were part of a great reconstruction programme for the Council's 76 hospitals, but he added that this was the last year that Joyce Green and all the other hospitals would be under L.C.C. control. At County Hall they were anxious that the hospitals should be transferred to the National Health Service as going concerns. Sir Allen Daley paid a tribute to the medical superintendent, Dr. Maurice Mitman, the matron, Miss Vivian, and the staff at Joyce Green for the first-class medical and surgical work which had been done at the hospital throughout the war notwithstanding recurring air-raid damage and continual danger.

## REFRIGERATION ANAESTHESIA

BY

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Refrigeration anaesthesia for limb amputations was introduced into the Royal Melbourne Hospital towards the end of 1944. Since then 25 lower-limb amputations have been performed with the aid of this technique, and they are here reported. With one exception all the amputations have been through the lower third of the thigh. It is not possible to reduce results fairly to statistical form owing to the diverse nature of the patients' condition. In the table the predominant constitutional factor has been indicated as either "atherosclerosis" or "diabetes mellitus." Some of the former group have had accompanying cardiac failure, renal failure, or cerebral degeneration; some of the latter group have been admitted in a coma or semicoma, and all have had atherosclerosis to a varying degree.

The local condition that required amputation has varied; most frequently it was progressive gangrene of the foot or gangrene complicated by severe pain or infection. In addition there were two cases of popliteal thrombosis accompanied by severe pain; two cases of gross infection of ulcers of the leg causing deterioration of the general condition of the patient despite conservative measures; two cases with epithelioma of the leg, one of which was severely infected and had metastatic glands in the groin, and the other equally badly infected and complicated by a pathological compound fracture of the tibia and fibula; finally, there was one case of a mangled foot in a shocked patient aged 69 years.

### Technique

The simplest technique has been used throughout this series; the more elaborate and costly apparatus employed by some clinics abroad has not been available.

**The Ice.**—The ice has been procured from a city firm in 50-lb. (22.68-kg.) bags. It is already crushed when delivered, though sometimes the pieces have to be broken further before use. When packing a limb it was found that ice obtained on the previous day and kept at room temperature overnight was easier to handle than that obtained on the same day, because the sharp edges had become rounded off.

**The Apparatus.**—Two methods have been used to retain the ice in position: a wooden box, 40 by 10 by 10 in. (100 by 25 by 25 cm.) lined with galvanized-iron sheeting and drained at one corner; or two mackintoshes held in position by long stout calico bandages or by a reversed single-limb cradle. Two bags of ice are required initially, and one or two daily for maintenance in cases of prolonged refrigeration.

### The Procedure

There are three main sources of infection—the patient, the ice, and the surgeon and his staff. The ice cannot be sterilized, but by adopting the usual procedures with the patient and the operating team the danger of infection is lessened. The limb and pubic region are shaved and the patient is placed on a canvas sheet. The abdomen and affected leg are given the routine pre-operative preparation and covered with sterile towels; the limb is then ready for the application of the tourniquet and placing in the ice.

The tourniquet is not an essential requirement at any stage of the procedure and may be dispensed with altogether. A tourniquet—of soft rubber pressure-tubing—has been used here for reasons given below. The tourniquet is first sterilized either by autoclaving or by boiling. The former method is preferable as a firmer grip may be obtained on the dry tourniquet. After the operator has scrubbed and the limb has been elevated, the sterile tourniquet is applied as tightly as possible just above the site of proposed amputation. It may be held with a reef knot, with sterile Kocher's clamps, or with sponge forceps. Occasionally the tourniquet has snapped some time after the application; hence it is wise to inspect it regularly.